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# Integrated Roles for Insects, Diseases and Decomposers in Fire Dominated Forests of the Inland Western United States: Past, Present and Future Forest Health

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**ABSTRACT.** Forest ecosystems characterizing much of the Inland Western United States occupy precarious, changing environments that can be moisture, temperature, and/or nutrient limited. Rapid vegetative adaptations to inherent change are critical to both plant community stability and to the survival of individual species. Biological decomposition processes are often constrained and natural wildfires represent an important recycling agent. Recycling of resources is critical. It is proposed that native insect, disease and other decomposer activities, plus natural wildfire, historically provided coordinated biological and physical processes that were integral to carbon, nitrogen, and other nutrient cycling, and to rapid evolution and adjustment of native conifers (and of their ecosystems) in this dynamic environment. Current conditions, as imposed by traditional harvesting and fire control over the last 100 years, plus the introduction of white pine blister rust in the early 1930s, have changed many native vegetative and microbial systems. Endemic insects and diseases have responded to

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these changes by increasing activities. Their effects counter many of the destabilizing actions of site deterioration, fuel accumulation, changes in species and genetic compositions, increased stand densities and impairment of recycling processes. At least in the short term, many ecosystems are now highly vulnerable to potential damage from high fuel wildfire and perhaps to the momentum of alternative biological decomposition processes. Genetic resources and other diversity components may be at especially high risk. Many current trends place future values in increasing danger until the course is changed. Adjusting cycling processes, stand density and species composition will often be more important than controlling individual pests when managing forest health for this region in the future.

## *PERSPECTIVES FOR THE FUTURE*

### *A Preemptive Approach*

An appropriate perspective for the concept of future "forest health," from the above point of view, requires consideration of far more than pest management or integrated pest management or even ecological pest control (Norris 1988). Pest management has historically been limited because it was invoked only when there was a perceived problem. Pest management has largely been defensive in nature. Management of overall forest health should emphasize preemptive actions. For example, fiber (fuel) accumulation, species composition and stand density management should be utilized. Appropriate management of these factors has a high probability of regulating forest health without directly managing individual insect and disease agents. There is a higher probability of retaining at least moderately high levels of productivity in Inland Western ecosystems if they are allowed to develop within the natural envelope from which they originally evolved. This is a much sounder approach than waiting for a problem of a complex developmental nature to occur and then attempting to regulate a "causal organism."

We must also remember that these types of ecosystems are very young. In their current form many are less than 2,000 years old and cannot yet (if ever) be considered stable (Whitlock 1992). Thus, they are highly susceptible to change, particularly to novel change, and can be expected to react by becoming even less stable. These ecosystems should be considered uniquely and highly susceptible to damage and to resultant losses in productivity with associated increases in stress and endemic pest activities.

### *Introduced Pests*

Introduced pests are a different matter than endemic insects and diseases. More introductions, like white pine blister rust or the gypsy moth, must be anticipated in the future. They are exceedingly destabilizing in the short-term and most ecosystems will require long recovery periods. Although movement of a pest is not unusual, with or without the involvement of humans, reducing the numbers and success of such introductions should remain one of our highest priorities in the ecosystem management forest health field.

### *Increasing Climate Variation*

Another complication with the next forest rotation may be even more climatic variation and more rapid global and/or regional climate change (Peters 1990). Natural adjustment (and management) of future forests may demand hitting an even more rapidly moving environmental target.

### *Future Management Direction*

Future actions should simulate natural disturbances and stimulate natural adjustment processes, or the effects they imposed, as they occurred during historical forest development. Current "out of phase" regional forests should be returned (gradually in most cases) to more ecologically balanced conditions. Future forest management should highlight ecosystem processes as keys for returning to a more balanced condition. Fiber (fuel/carbon) accumulation and cycling is the highest priority ecosystem process that must be returned to near historical levels. This function is the most out of phase with historical norms and directly affects density and species composition. Endemic insects and diseases should be recognized as an important and integral part of regulating all three. They also can be valuable indicators of imbalances and should be useful to, as well as a problem for, the natural resource managers of the future.

In any case, forests will continue to change and insects and diseases will continue to function within them. Depending on the nature of future changes (variation, amount, direction, duration) and the organism, insect and disease actions can either help stabilize or destabilize forest ecosystems. Human interaction with forests, and insect/disease agents will impact this process.

### *Choices*

We do have choices. In some cases we may opt to leave things as they are, doing things much the same, because economics demands we do so . . . despite associated environmental costs. In others, we may be forced, by law, to intercede for the protection of non-forest (and forest) values, irrespective of cost. Hopefully, we can also choose to regulate many of our forests in more natural ways, and continue producing badly needed amenities and fiber while protecting forest components and processes.

### *An Opportunity*

There is an obvious window of opportunity to harvest wood products as part of regulating fiber (fuel) accumulations. We should be able to regulate and use that fiber (sequester the carbon) while protecting basic ecosytem properties (maintain sufficient organic reserves) and processes (including fire), especially those that provide forest communities (and species) with the ability to change with their environment. Although compromises must be struck, and forestry practices and forest products processing will be more demanding and costly, we can accomplish appropriate fiber extractions without excessive loss of basic diversity, stability, productivity or value–a true challenge for the future.

## *A DYNAMIC ENVIRONMENT*

### *An Environment Characterized by Change and Diversity*

The Inland Western United States generally represents a region that is rugged, mountainous, highly dissected and that often contains young geological components. Typically, its climate is highly diverse and variable across both time and space. Most moisture arrives as winter snow. In recent geological time, major disturbances have been common. Some examples include ash depositions from Cascade Range volcanoes, like the heavy deposition of Mount Mazama ash 6,700 years ago (Fryxell 1965), and the climatic effects of continental glacier ice near Spokane, Washington only 14,000 years ago (Whitlock 1992). During the last 14,000 years, regional climates have progressed from cold/wet to cool/dry to cool/moist, with accompanying changes in vegetation (Whitlock 1992). The ash depositions increased soil moisture storage in parts of the region, which brought about additional changes in effective climate (Geist and Cochran 1991). In some cases, this increased moisture storage allowed vegetation more characteristic of a moist, west coast climate or of a riparian site to occupy otherwise moisture limited areas (Meurisse et al. 1991). However, these forests are at especially high risk during extended dry periods.

Glacial scouring of valley bottoms created many thin, compacted soils with water and nutrient storage capacity that is extremely limited and, if physically disturbed or further compacted, that can easily lose much productivity potential (Meurisse et al. 1991). Many other shallow soils characteristic of the region are also fragile, especially where organic matter incorporated in upper soil horizons is limited (Harvey et al. 1993a).

In short, these are constantly changing environments where vegetation is often near its environmental limits for at least some species (especially climax conifers) in most forests. Many of our actions have the potential to rapidly alter them further.

### *Decomposition Processes*

The typical temperature and moisture patterns of wet, cold winters and warm, dry summers can be severely limiting to biological decomposition (Olsen 1963; Harvey et al. 1979; Edmonds 1991). This allows accumulations of plant debris which, when combined with frequent lightning in summer rainstorms (that yield little water), repeatedly sets the stage for wildfire ignition (Arno 1980). The resulting fires are important. In the absence of fire, critical nutrients are tied up in plant debris, causing the site to become nutrient limited.

Thus, these forests are dependent on a combination of biological (primarily microbes and insects) and fire decomposition processes to regulate nutrient availability and cycling (Olsen 1981). Which of them dominates is dependent on site and climate (Harvey et al. 1993b). For example, fire dominates and occurs frequently in dry ponderosa pine forests and to a lesser extent with Douglas-fir, but biological decomposition dominates moist cedar/hemlock sites where fires occur much less frequently (Habeck and Mutch 1973; Arno 1980; Harvey et al. 1993b). The latter forest types usually occupy sites with deep, ash cap soils. Growth of vegetation on ash cap soils is less limited than on other soils because of the relatively high water and nutrient storage capacity. This likely further inhibits the ability of above-ground, more climate-limited biological decomposition processes to keep up with carbon accumulation.

## *ANALYZING THE PAST*

### *Potential Insect and Disease Benefits*

Characterizing this unique, dynamic environment permits analysis of past roles for insects and diseases. To reemphasize, historical environments were diverse and constantly changed so vegetation likely experienced frequent stress. Biological decomposition may have been constrained but recycling of nutrients was assured by fire (Olsen 1981). Fire-resistant species dominated sites that often burned. Most native "pests" were stress sensitive, i.e., they tended to attack unthrifty or stressed individuals (Waring 1987; Stoszek 1988). This probably generated the highest mortality in the poorest adjusted vegetation, an obvious benefit (Harvey et al. 1992). With fungal pathogens and at least some insects, it also probably accelerated decomposition, another obvious benefit (Mattson and Addy 1975). Localized centers of insect and disease activities created diversity in forest structure and species composition, also a benefit (van der Kamp 1991).

All of these helped to stabilize and diversify long-lived (100-400 years) tree communities that occupied potentially resource-limited sites with climates that changed over time periods which varied from days to several thousand years. Insects and diseases would have been integral to the development and function of these ecosystems (Martin 1988; Burdon 1991; Jarosz et al. 1991; Harvey et al. 1992).

## *THE PRESENT*

### *Changing Conditions*

In the present world, several things have altered the normal historical development and function of these forests. Perhaps most importantly, the numbers and types of disturbances are changing. Fires are often extinguished quickly, so forests burn less frequently (Baker 1992). However, wildfire effects can be severe in the presence of accumulated fuels and may have an associated loss of vegetation and organic matter storage (Brown 1983; Harvey et al. 1993a). Post-fire erosion of surface mineral soil horizons can also be a problem, especially with hot fires. As a result, representation of fire-adapted species in forest communities has been reduced. Non-fire-adapted species are invading areas where they were historically excluded by frequent fire (Monnig and Byler 1992; O'Laughlin 1994). Also, tree densities are vastly exceeding historical levels (Baker

1988; Monnig and Byler 1992; O'Laughlin 1994). Disturbances, in the absence of fire, such as harvesting, are increasing and may result in soil compaction, dislocation of surface horizons (especially reduction of ash cap depth) or inappropriate organic matter depletion (Harvey et al. 1993a). Tree removals associated with harvests have probably not improved adaptation of the community to the site, though they may not regularly reduce it (Wilusz and Giertych 1974).

In white and sugar pine country *(Pinus monticola* Dougl., *P. lambertiana* Dougl.) the introduction of white pine blister rust (*Cronartium ribicola* J.C. Fisch.) early in the century is reducing representation of these pines in many forest communities, to less than half of what they were even 40 years ago (Monnig and Byler 1992; O'Laughlin 1994). Fire-adapted species such as ponderosa pine and western larch (*P. ponderosa* Dougl. ex Laws., *Larix occidentalis* Nutt.), white and sugar pines, all tend to be broadly adapted species (Rehfeldt 1990) and appear relatively tolerant of many native insects and diseases (Monnig and Byler 1992). They are strongly reduced in the absence of fire. Other native conifer species are narrowly adapted and not very tolerant of changes in their environment or to many native insects and diseases. They are currently increasing rapidly (Monnig and Byler 1992; O'Laughlin 1994).

### *Ecosystem Response*

The ecosystems have responded appropriately. They are now faced with reduced nutrient cycling, increased tree density, more shade tolerant late seral and climax species, less broadly adapted pioneer and early seral, "pest" tolerant species, with accompanying reduced vegetation adjustment to current site conditions. Stress levels have likely increased accordingly (McDonald 1990). Activities of "pests" have also increased (Baker 1988; Monnig and Byler 1992; Hessburg et al. 1993). These forests are adjusting (adapting) to prevailing conditions with the tools still at hand . . . insects, diseases, microbial decomposition, and sporadic, often severe wildfire.

### *An Accommodation*

Where forest changes remain within reasonable natural variation, the ecosystems will eventually counter pest activities as they adjust. To facilitate that process, we should also adjust current human influences and restore many previously affected sites to better simulate situations in the past. No action, so long as fire regimes are not restored, will only serve to accelerate negative change. Current levels of insect and disease activity have common, sometimes complex environmental causes. Most have less to do with the individual organism than with present environmental conditions and the history of their development. Insects and diseases are a problem primarily because they are now extensive and highly active, creating an appearance and condition not in harmony with how society thinks it should be. However, real damage, in the form of severe wildfire effects, are increased by these conditions. Without modification of current actions and conditions, time lines for recovery of affected forests will continue to be extended.

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